UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

B-52H, T/N 60-053

20TH EXPEDITIONARY BOMB SQUADRON
36TH WING
ANDERSEN AIR FORCE BASE, GUAM

LOCATION: 30 NAUTICAL MILES NORTHWEST OF GUAM

DATE OF ACCIDENT: 21 JULY 2008

BOARD PRESIDENT: BRIGADIER GENERAL MARK A. BARRETT

Conducted IAW Air Force Instruction 51-503

EXECUTIVE SUMMARY
AIRCRAFT ACCIDENT INVESTIGATION

B-52H, T/N 60-053
30 NM NORTHWEST OF GUAM
21 JULY 2008

On July 21, 2008, at approximately 0955 local time (L), a B-52H aircraft, tail number 60-053, crashed into the ocean 30 nautical miles (NM) northwest of Guam. This aircraft was assigned to the 20th Bomb Squadron, 2d Bomb Wing, Barksdale Air Force Base (AFB), Louisiana, and deployed to the 20th Expeditionary Bomb Squadron, 36th Wing, Andersen AFB, Guam. The aircraft was destroyed. All six aircrew members are presumed to have died instantly as a result of the mishap. The aircraft had no weapons on board.

RAIDER 21, the mishap aircraft (MA), departed Andersen AFB, Guam, at 0859L to accomplish a local training mission that included performing a flyby in support of the Guam Liberation Day celebration. The flyby was to occur at 1000L in downtown Agana, Guam, near the World War II Park and the Governor's Complex, at 1,000 feet. A 2-ship flight of F-15Es, COLT 11 flight, was also scheduled to perform in the flyby, one minute after the MA. After the MA was airborne, it proceeded to and entered the pre-planned holding orbit at 14,000 feet, 30 NM northwest of Guam. At 0930L, COLT 11 flight departed Andersen AFB, proceeded to the flyby holding orbit and established holding 1,000 feet above and approximately 4 to 6 miles behind the MA.

At approximately 0953L, the mishap crew (MC) informed the Air Traffic Control (ATC) authority they were about to leave the holding orbit and confirmed the approach corridor from the holding orbit to Guam was clear. COLT 11 flight turned away from the MA to gain the desired one minute spacing and last saw the MA in a left turn toward the coast of Guam. The MA continued its left hand turn toward the flyby inbound leg and began a descent. After approximately one minute, ATC radar returns no longer tracked the MA, and it is assumed the MA impacted the surface of the ocean at approximately 0955L, 30 NM northwest of Guam.

The Accident Investigation Board President found by clear and convincing evidence that the cause of this mishap was a mis-positioning of the stabilizer trim (stab trim) mechanism. With no eyewitness account, surviving aircrew members, emergency radio calls or "black box" recordings and with minimal recovered aircraft control systems/instruments, the specific reason the stab trim was in an improper position cannot be determined. The Accident Board President found two factors which contributed substantially to the mishap: 1) the combination of low altitude with a descending left turn of the MA; and 2) late recognition of the serious nature of the situation by the MC. However, even an experienced aircrew could have found it difficult to recognize, assess, and recover from the very rapidly developing situation involving the stab trim setting.

SUMMARY OF FACTS AND STATEMENT OF OPINION
B-52H, T/N 60-053
30 NM NORTHWEST OF GUAM
21 JULY 2008

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COMMONLY USED ACRONYMS AND ABBREVIATIONS

ACC	Air Combat Command
ADO	Assistant Director of Operations
ADVON	Advanced Team
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AGE	Aerospace Ground Equipment
AIB	Accident Investigation Board
ALO	Air Liaison Officer
AMXS	Aircraft Maintenance Squadron
AOR	Area of Responsibility
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
ATP	Advanced Targeting Pod
BAFB	Barksdale Air Force Base
BS	Bomb Squadron
BW	Bomb Wing
CAF	Combat Air Force
CAP	Combat Air Patrol
CSPPI	Catapult Safety Pin Pull Initiator
DO	Director of Operations
DoD	Department of Defense
DV	Distinguished Visitor
EAMXS	Expeditionary Aircraft Maintenance Squadron
EBS	Expeditionary Bomb Squadron
EFS	Expeditionary Fighter Squadron
ELT	Emergency Locator Transmitter
EWO	Electronic Warfare Officer
Fam	Familiarization
Freq	Frequency
Fragged	As planned or as briefed
GovGuam	Government of Guam
HHD	Higher Headquarters Directed
HPO	Hourly Post Flight
IAW	In Accordance With
IMDS	Integrated Maintenance Data System
In Fluid	In fluid formation
IP	Instructor Pilot
IR	Infrared or Instructor Radar
KIAS	Knots Indicated Air Speed
L	Local Time
LANTIRN	Low-Altitude Navigation and Targeting Infrared System for Night
LITENING	Laser Infrared Targeting and Navigating
LNO	Liaison Officer
LOWAT	Low Altitude Training
MA	Mishap Aircraft
MARSA	Military Assumes Responsibilities of Separation of Aircraft
MC	Mishap Crew
MCP	Mishap Copilot
MDS	Mission Design Series
MEW	Mishap Electronic Warfare Officer
MFS	Mishap Flight Surgeon
MN	Mishap Navigator
MOP	Monthly Operating Plan
MP	Mishap Pilot
MPC	Mission Planning Cell
MRN	Mishap Radar Navigator
MSL	Mean Sea Level
NASA	National Aeronautics and Space Administration
NM	Nautical Mile
NORDO	No Radio
NOTAMS	Notices to Airmen
OAS	Offensive Avionics Systems
OEF	Operation ENDURING FREEDOM
OG	Operations Group
ONE	Operation NOBLE EAGLE
Ops Sup	Operations Supervisor/TOP3S
ORM	Operational Risk Management
OSS	Operational Support Squadron
PACAF	Pacific Air Forces
PCS	Permanent Change of Station
PF	Pilot Flying
PNF	Pilot Not Flying
POC	Point of Contact
PTOB	Pre-takeoff Brief
Quals	Qualifications
RAP	Ready Aircrew Program
RIMPAC	Rim of the Pacific
Rolex	Being pushed back in time
ROV	Remotely Operated Vehicle
SAR	Search and Rescue
SOF	Supervisor of Flying
Spins	Special Instructions
Stab Trim	Stabilizer Trim
TACAN	Tactical Air Navigation
TCTO	Time Compliance Technical Order
TDY	Temporary Duty
T/N	Tail Number
TO	Technical Order
TOP3	Operations Supervisor
TOT	Time Over Target
USAFE	United States Air Forces in Europe
VID	Visually Identify
VFR	Visual Flight Rules
WG	Wing
WSO	Weapon System Operator

The above list was compiled from the Summary of Facts, the Statement of Opinion, the Index of Tabs, and Witness Testimony (Tab V).

SUMMARY OF FACTS

1. AUTHORITY, PURPOSE, AND CIRCUMSTANCES

a. Authority

On 21 July 2008, General John D.W. Corley, Commander, Air Combat Command, appointed Brigadier General Mark A. Barrett to conduct an aircraft accident investigation of a mishap that occurred on 21 July 2008 involving a B-52H aircraft 30 nautical miles (NM) northwest of Guam (Tab Y-3). The investigation was conducted at Andersen Air Force Base (AFB), Guam, from 23 August 2008 through 3 September 2008, and at Langley AFB, Virginia, from 4 September 2008 through 24 November 2008. Board members were Lieutenant Colonel Saritha R. Anjilvel (Legal), Lieutenant Colonel Lance T. Frye (Medical), Major Chandler L. Bigelow (Pilot), Major Stanley Peter, Jr. (Navigator), Captain Kathy Malowney (Assistant Legal), Master Sergeant Frantz J. Jean-Pierre (Maintenance), Master Sergeant William J. Green (Egress Systems), Master Sergeant Richard C. Butturini (Recorder), Technical Sergeant Shawn L. Bauer (Court Reporter), and Staff Sergeant Shane A. Merillat (Assistant Recorder) (Tab Y-3 - Y-5).

b. Purpose

The purpose of this investigation is to provide a publicly releasable report of the facts and circumstances surrounding the accident, to include a statement of opinion on the cause or causes of the accident; to gather and preserve evidence for claims, litigation, disciplinary, and adverse administrative actions; and for other purposes.

c. Circumstances

The accident investigation board (AIB) was convened to investigate the Class A accident involving a B-52H, tail number (T/N) 60-053, deployed and temporarily assigned to the 20th Expeditionary Bomb Squadron, 36th Wing, Andersen AFB, Guam, which occurred during a local training mission that included a flyby in support of Guam Liberation Day celebration on 21 July 2008 (Tabs B-3, Y-3 - Y-5).

2. ACCIDENT SUMMARY

The mishap aircraft (MA), a B-52H, T/N 60-053, call sign RAIDER 21, impacted the ocean approximately 30 NM northwest of Guam, an island within the Pacific Ocean Marianas (Tab B-3). The mishap crewmembers (MC) were: Major Christopher M. Cooper, the Mishap Pilot (MP); Captain Michael K. Dodson, the Mishap Copilot (MCP); Major Brent D. Williams, the Mishap Radar Navigator (MRN); First Lieutenant Joshua D. Shepherd, the Mishap Navigator (MN); First Lieutenant Robert D. Gerren (posthumously promoted to the grade of Captain, United States Air Force, effective 11 October 2007), the Mishap Electronic Warfare Officer (MEW); and Colonel George T. Martin, the Mishap Flight Surgeon (MFS) (Tab B-3). All six members of the MC are presumed to have died instantly as a result of the mishap (Tabs B-3, X-3). No other military or civilian casualties occurred during this accident (Tab B-3). The MA was destroyed, with military equipment losses totaling $65,718,834 (Tab P-3). There were no

weapons on board (Tab O-3). There was no damage to private property as a result of this mishap (Tab P-4). Search and rescue (SAR) actions commenced immediately upon discovery of the mishap and included multiple United States Air Force, Navy, Coast Guard, Drug Enforcement Administration, and Guam civilian air and sea resources (Tabs O-3 - O-5, O-44 - O-45, V-5.6).

3. BACKGROUND

The parent unit of the MA is the 20th Bomb Squadron, 2d Bomb Wing at Barksdale AFB, Louisiana. The MA was deployed and temporarily assigned to the 20th Expeditionary Bomb Squadron, 36th Wing, Andersen AFB, Guam (Tabs B-3, CC-11).

a. 2d Bomb Wing (2 BW)

The 2 BW is the oldest bomb wing in the Air Force and largest bomb wing in Air Combat Command. The 2 BW's mission is to provide responsive, flexible and accurate bomber combat power and expeditionary combat support to warfighting commanders, anytime and anywhere (Tab CC-3 - CC-5).

The 2d Bomb Wing Symbol

b. 20th Bomb Squadron (20 BS)

The mission of the 20 BS "Buccaneers" is to conduct combat operations in the B-52 to support worldwide conventional and nuclear taskings and provide long-range, heavy strike, initial response and sustained firepower in support of all regional and global warfighting commanders. The squadron is the nation's oldest continuous bomb squadron and was established June 26, 1917, at Camp Kelly, Texas (Tab CC-6).

The 20th Bomb Squadron Symbol

c. 36th Wing (36 WG)

As the host unit at Andersen Air Force Base, Guam, the 36 WG's mission is to provide a United States-based lethal warfighting platform for the employment, deployment, reception and throughput of air and space forces in the Asia-Pacific region (Tab CC-7 - CC-8).

The 36th Wing Symbol

d. 20th Expeditionary Bomb Squadron (20 EBS)

The 20 EBS's mission is to deter and dissuade regional aggression in the Pacific Area of Responsibility as part of the Department of Defense's continuous bomber presence mission in the Pacific (Tab CC-11).

The 20th Expeditionary Bomb Squadron Symbol

e. B-52H Stratofortress

The B-52H is a long-range, heavy bomber that can perform a variety of missions. The bomber is capable of flying at high subsonic speeds at altitudes up to 50,000 feet. It can carry nuclear or precision guided conventional ordnance with worldwide precision navigation capability. The first of 102 B-52H's was delivered to Strategic Air Command in May 1961 (Tab CC-9 - CC-10).

B-52H Stratofortress - T/N 60-053

B-52H, T/N 60-053, 21 July 2008

4. SEQUENCE OF EVENTS

a. Mission

The MA was flown from Andersen AFB on 21 July 2008 to accomplish a local mission. In conjunction with the training portion of their mission, the MC was scheduled to accomplish a flyby in support of the Guam Liberation Day celebration, as authorized in accordance with (IAW) Air Force Instruction 11-209, *Aerial Event Policy and Procedures*, Pacific Air Forces Command Supplement, 4 May 2007 (Tabs K-7 - K-8, R-158, R-165).

b. Planning

Mission planning for the sortie was known as a "show and go" which means a squadron mission planning cell (MPC) was responsible for overall mission planning for the MC (Tab BB-24 - BB-25). On 21 July, the MC arrived at the squadron for their morning brief scheduled for 0500 local time (L). The MC was briefed by a MPC team member and the flyby point of contact (POC). This pre-takeoff brief (PTOB) included weather, intelligence, overall mission, target study, and the flyby briefing (Tab R-158). The MC was briefed a 1015L flyby time at an altitude of 1,000 feet and 300 knots and to descend in the holding orbit (Tabs R-165, AA-9). The flyby was to occur in the vicinity of downtown Agana, Guam, near the World War II Park and the Governor's Complex (Tabs AA-10, AA-12). The MC was briefed there would be a 2-ship of F-15Es, COLT 11 flight, scheduled to perform in the flyby one minute after the MA (Tab AA-11). COLT 11 had been briefed previously by the flyby POC to establish in the holding orbit at 15,000 feet, 1,000 feet above the MA (Tabs V-4.4, AA-11). During the PTOB, the MC asked whether they had to descend in the holding orbit or if they could descend on the inbound leg. The flyby POC left it up to the MC's discretion on how to control their descent and timing (Tab R-141). The 20 EBS's Director of Operations was present at the end of the MC's PTOB (Tab R-120). After the conclusion of the PTOB, the MC continued their standard crew brief (Tab R-158). Although there is no evidence of what items were covered during the MC's crew brief, standard crew briefs generally cover all activities to be accomplished from ground operations through landing. The MC reviewed Notices to Airmen (NOTAMS) and filed their flight plan prior to leaving the squadron for their flight (Tabs K-4, BB-62). The MC left the squadron around 0700L for a planned takeoff of 0900L (Tabs K-4, V-1.9).

c. Preflight

MA's preflight inspection was accomplished on 19 July 2008 (Tabs R-190, R-192). During this inspection, seven tires were identified as requiring inflation to the proper pressure and the #1 flap had a loose panel (Tabs R-192, R-194). These were repaired prior to flight (Tabs R-192, U-21). Sortie preflight was accomplished on 21 July 2008, including a stabilizer trim check and flight control check (Tabs R-182, V-11.3). Prior to starting engines, the MEW reported a noise emanating from the MA's air conditioning system. Maintenance personnel responded, investigated, and determined the noise to be inconsequential. The rest of the ground checks proceeded normally (Tabs R-181, V-11.4).

d. Summary of Accident

The MC took off at 0859L (Tab O-3). They climbed to 14,000 feet and entered their holding orbit approximately 30 NM northwest of Guam (Tab N-5; Figure 1). The MC made radio contact with the flyby POC at approximately 0925L. At 0927L, COLT 11 flight departed Andersen AFB and proceeded to the flyby holding orbit approximately 1,000 feet above and 4 to 6 miles behind the MA (Tabs O-3, R-4, V-4.7). At approximately 0935L, the flyby POC informed the MC the Time Over Target (TOT), over flyby center, had changed from 1015L to 1000L. At 0940L, the MC made contact with COLT 11 flight (Tab R-165). The MC and COLT 11 flight informed Air Traffic Control (ATC) they were now responsible for ensuring the separation of their aircraft (Tab N-5). At 0948L, the MC informed ATC they were about to begin their inbound leg and descent for the flyby (Tab N-6). At 0952L, the MC advised ATC that they were one minute from beginning their descent to 1000 feet and confirmed with ATC that the approach corridor from the holding orbit to Guam was clear of other aircraft (Tab N-7). This was the last known communication from the MC. COLT 11 flight turned away from the MA to gain the desired one minute spacing and last saw the MA in a left turn toward the coast of Guam. The MA continued its left hand turn toward the flyby inbound heading and began a descent to a low altitude environment, toward 1000 feet (Tab V-4.7 - V-4.8). At 0955L, ATC reported radar contact lost (Tab N-7). ATC made eight attempts to contact the MC with no success between 0955L and 1009L. COLT 11 flight and another airborne B-52H aircraft, RAIDER 22, also attempted contact with no success (Tab N-8 - N-9). It is presumed the MA impacted the ocean at approximately 0955L (Tabs B-3, C-3). There is no evidence to indicate which pilot was flying the MA at the time of the mishap.

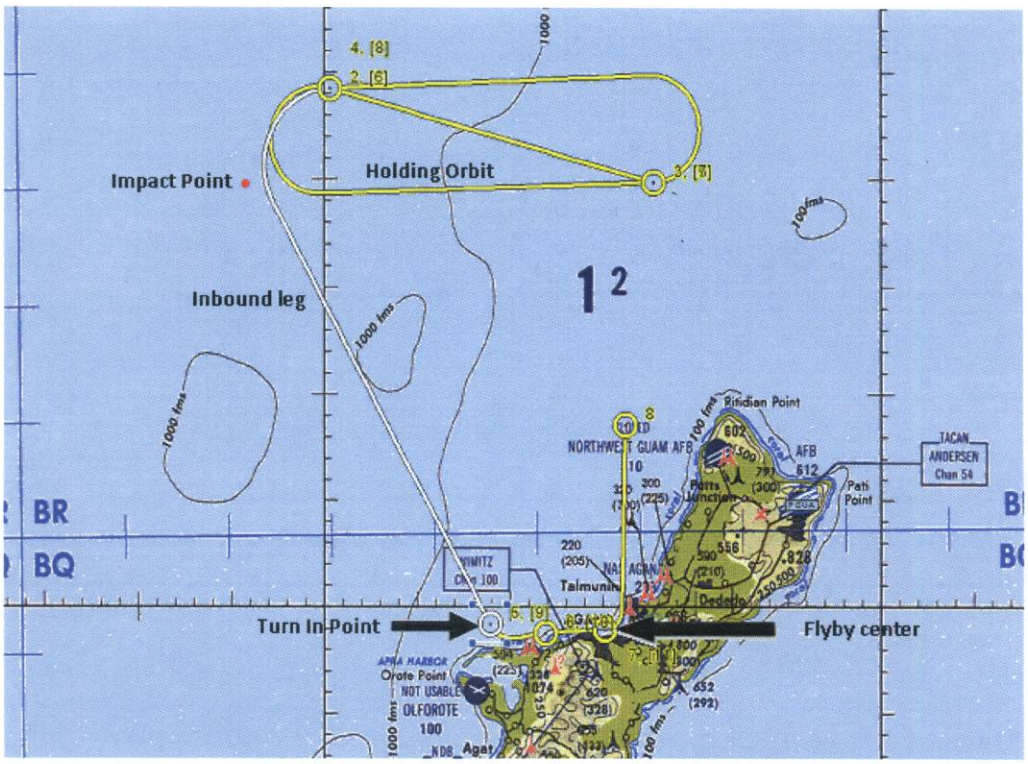

Figure 1: Chart of Mishap Area

e. Impact

A debris field was found at North 13 49.930 East 144 26.700, an area 30 NM northwest of Guam (Tab O-3). It was described as approximately 400 yards long by 150 yards wide (Tabs O-42, R-8, R-33, S-3 - S-4, S-9). Very little data exists regarding the MA's flight parameters at impact. However, Boeing, the manufacturer of the MA, used ATC radar data that included latitude and longitude, altitude from the MA's on board transponder, and time data to develop a model that would approximate the MA's flight path beginning at 14,000 feet mean sea level (MSL) down to its last reported position on radar, approximately 2,000 feet MSL (Tabs J-23, M-3 - M-264; Figure 2). Additionally, temperature data for the day and area of the accident was obtained for airspeed calculations (Tab J-23). The resulting descent profile depicts a rapid descent from 14,000 feet down to the surface of the ocean over a very short ground distance of approximately 5 NM. At impact, the MA had exceeded its maximum operational airspeed and entered the ocean at a steep angle (Tab J-23 - J-24).

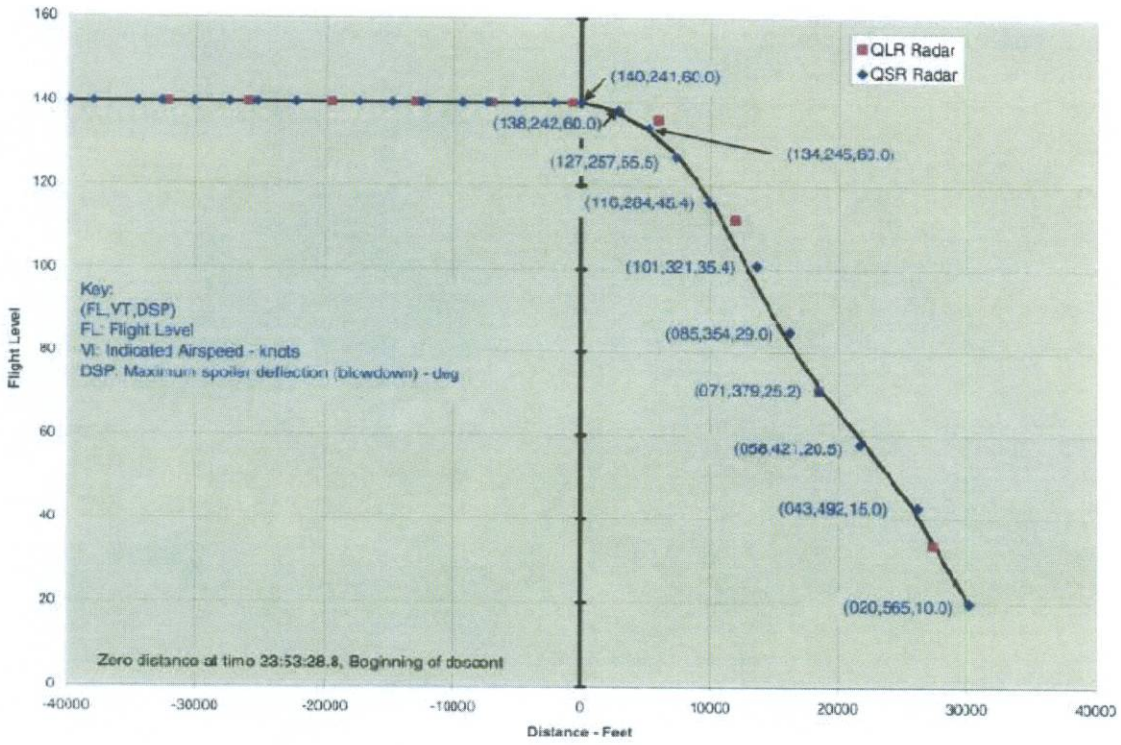

Figure 2 - MA Descent Profile

f. Egress, Survival, and Life Support Equipment

Egress, survival, and life support equipment items were identified and submitted for analysis. This equipment included the MCP's ejection seat drogue chute, the MRN and MN's ejection seats and escape hatches, and the MP, MRN, and MN's parachutes (Tabs H-22 - H-85, J-30, CC-16 - CC-17).

Ejection sequence and ejection envelope

According to T.O. 1B-52H-1, the escape system, consisting of ejection seats, escape hatches and automatic opening parachutes, is designed for safe operation up to 400 Knots Indicated Air Speed (KIAS) and a minimum altitude of 15,000 feet in a dive or 2,000 feet for level flight. Outside of these parameters, the chance of a successful ejection significantly decreases. The MP, MRN, and MN attempted ejection, but were unsuccessful (Tabs J-219 - J-222, C-16 - CC-17). Evidence suggests that the MP and MRN exited the aircraft but did not complete a successful ejection (Tabs H-23, H-25, H-67, CC-16 - CC-17). The MN initiated ejection but did not exit the MA (Tabs J-219 - J-222, CC-16 - CC-17). The remaining members of the MC were presumed to be in their seats when the MA impacted the ocean. All ejection attempts were made outside the safe ejection envelope (Tabs J-219 - J-222, CC-16 - CC-17).

System deficiencies or maintenance

Cap sealant was required on both the Gunner's and Electronic Warfare Officer's escape hatches and documented in the aircraft forms (Tab U-20). Cap sealant is used to plug an access hole to prevent water intrusion for corrosion prevention. This discrepancy is minor and would not affect the operation of the escape hatch (Tab CC-16 - CC-17).

Inspection currency

The escape system inspections were accurate and the equipment was operational at time of mishap. A 30-day interval inspection of the ejection seats, escape hatches and survival equipment was accomplished on 16 July 2008 (Tab U-25 - U-26).

The Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland, evaluated reliability and performance of the M3A2 initiator and granted shelf life limit increase from 234 months to 246 months (Tab U-24). The 784 Combat Sustainment Group, Hill AFB, granted an extension to the MA's 16 M3A2 initiators until 31 December 2008 (Tab D-15 - D-16). During analysis of the salvaged MA ejection seats, it was determined that the M3A2 initiators were operational (Tab CC-16 - CC-17).

g. Search and Rescue (SAR)

Approximately fourteen SAR assets were dispatched expeditiously beginning at 1010L (Tabs O-44 - O-45, R-46 - R-47). The MA's location was discovered at approximately 1034L by the on scene commander, the flight lead of COLT 11 (Tabs O-3, R-9 -R-10). RAIDER 22 took over as on scene commander from COLT 11 at approximately 1144L (Tabs O-4, R-11, R-50). The search and rescue was a joint effort including air and sea rescue assets from the United States Air Force, Navy, Coast Guard, Drug Enforcement Administration, and Guam fire, rescue, and police departments (Tabs O-4, O-44 - O-45, V-5.5). Most of the SAR assets were from Guam, but some came from as far away as Japan (Tab O-23). Upon reaching the debris field, SAR elements described a large area with what looked like fuel and oil on the surface of the water (Tabs O-42, R-9, R-19 - R-21, R-35, R-69). The SAR effort was extensive and thorough, with 49 searches covering 7,800 square NM, spanning over 3 days (Tab O-3 - O-46).

The MA wreckage initially recovered included approximately 126 egress, survival, life support, and aircraft parts (Tabs H-22 - H-23, Q-15 - Q-19, R-9, R-34, R-49, R-71). SAR assets heard an intermittent beacon (Tabs O-4, R-11, R-38). One possible source of the beacon could be one of the MC's emergency locator transmitters (ELT). An ELT is a transmitter attached to the back of a crewmember's parachute and used to assist SAR assets in locating the crewmember's position in a rescue situation. SAR assets attempted to locate the source of the beacon; no definitive source for the beacon could be identified. However, the location of the beacon corresponded with the debris field (Tabs R-11, R-38).

Life rafts were spotted by SAR assets when they arrived at the debris field (Tabs R-9 - R-10, R-21 - R-22, R-37, R-48 - R-49). Four life rafts were recovered; three were identified as belonging to the MP, MN, and MEW, with one life raft unidentified (Tabs H-20, H-22 - H-23). The life rafts normally deploy when the aircrew member's survival seat kit opens after separation from the ejection seat. However, for the aircrew who did not eject, it is likely the impact force caused the seat kits to open and deploy or partially deploy the rafts (Tab H-7, H-24, H-27).

h. Recovery of Remains

COLT 11 flight's initial sighting of the debris field was pivotal to SAR efforts. They identified the area where the first remains were recovered at around 1034L, approximately 40 minutes after the mishap occurred (Tab R-8 - R-9). The first remains were recovered by a United States Coast Guard vessel at 1042L (Tab O-8). The second remains were recovered soon after by the same Coast Guard vessel at 1138L (Tab O-10). Additional remains were recovered at 1300L and 1334L (Tab O-11). Naval helicopter RESCUE 00 departed Andersen AFB with a doctor on board at 1104L (Tab O-3). The helicopter secured the remains from the Coast Guard vessels and transferred them to the U.S. Naval Hospital Guam (Tab X-3). Remains were also recovered during the salvage operations and transferred to the U.S. Naval Hospital Guam (Tab X-3). Mortuary affairs were handled by Andersen AFB Mortuary Services (Tab X-3).

i. Salvage Operations

Salvage operations occurred from 6 September 2008 to 27 October 2008. The U.S. Navy provided two Remotely Operated Vehicles (ROV), small submarines used for search and recovery. The ROVs incorporated the latest in technology, making it possible to reach the debris field at its approximate depth of 12,000 feet below sea level (Tabs CC-13, CC-15). Salvage operations recovered remains, egress equipment, and pieces of the MA (Tabs X-3, CC-16).

5. MAINTENANCE

a. Forms Documentation

The 36th Aircraft Maintenance Unit, Andersen AFB, maintained the aircraft forms for the MA. Maintenance is documented on Air Force Technical Order (AFTO) 781 series forms and in the Integrated Maintenance Data System (IMDS). AFTO 781 series forms are hard copy forms used to document daily maintenance actions. They are retained in a binder specifically assigned to

each aircraft. IMDS is a database of aircraft discrepancies, repair actions, and flying history. Aircraft AFTO 781 series forms and IMDS were reviewed to determine air worthiness up to the point of the mishap (Tabs D-5 - D-13, U-4, U-14 - U-21, U-25 - U-27). Minor documentation errors were found. There is no evidence to suggest these minor documentation errors were a factor.

Regulations allow non-critical maintenance items to be deferred until more extensive time is available for repair. The MA flew with six non-critical maintenance items to be accomplished as detailed in the AFTO 781A forms:

1. The outboard engines strut spar extension was to be inspected by 14 March 2009. This strut mounts the engines to the wing. This inspection was not overdue at the time of the mishap (Tab D-7).

2. The copilot's hatch thermal curtain was torn (Tab D-7). The thermal curtain prevents flash blindness due to nuclear detonation.

3. Video was not uploaded in the Laser Infrared Targeting and Navigating (LITENING) pod, a precision targeting pod system. Video can be uploaded in the LITENING pod depending upon the mission requirements. However, video was not required for this mission (Tab D-7).

4. The ALQ-155 horn antenna on the nose was to be removed because this equipment is no longer required for the B-52 fleet (Tab D-8). The ALQ-155 was an electronic warfare system that disrupted enemy radar systems.

5 & 6. Cap sealant was required on both the Gunner's and Electronic Warfare Officer's escape hatches (Tab D-8). These items were not performed before the mishap flight because the sealant requires 12 to 24 hours of down time to harden (Tab U-20). Normally this type of maintenance would be performed when the aircraft is down for long term periodic maintenance and does not affect the ejection sequence (Tab CC-16 - CC-17).

There is no evidence to suggest these open discrepancies were a factor.

b. Inspections

(1) Mishap Aircraft

AFTO 781K is the aircraft form that shows inspection status, next major inspections, periodic scheduled inspections, urgent actions, routine maintenance, and maintenance waived awaiting parts (Tab D-5).

The MA's AFTO 781K had ten non-critical maintenance items scheduled. None of these inspections were overdue as of 21 July 2008. Eight of these were scheduled to be accomplished at the centralized maintenance repair center (depot level). Depot inspections are major inspections scheduled every four years. The other two maintenance items were scheduled battery replacements (Tab D-6 - D-11).

The MA's AFTO 781K, section D, had 22 delayed discrepancies. A delayed discrepancy is the term used when an aircraft requires new or repaired parts that have not been received yet, causing a delay in the repair. Sixteen of these delayed discrepancies were for M3A2 initiators (Tab D-12 - D-13). Each ejection seat in the aircraft contains these initiators. The initiators are used to start the ejection sequence for each individual seat (Tab V-12.2). After extensive testing was completed to ensure the initiators were operating correctly and safely, a time extension was granted for their replacement until 31 December 2008. This extension was granted after testing by the 784th Combat Sustainment Group at Hill AFB (Tabs D-15 - D-16, U-24, V-12.3 - V-12.4). The other six delayed discrepancies were for minor system repairs which were not overdue (Tab U-17 - U-19).

MA's preflight inspection was accomplished on 19 July 2008 (Tabs R-190, R-192). During this inspection, seven tires were identified as requiring inflation to the proper pressure and the #1 flap had a loose panel (Tabs R-192, R-194). These were repaired prior to flight (Tabs R-192, U-21).

(2) Mishap Engines

The last major scheduled engine inspection was performed at 16,469.0 flight hours on 13 February 2008 during the 300-hour Periodic Phase Inspection (Tab U-3). The MA had flown 110.8 flight hours since the last inspection (Tab D-3).

c. Maintenance Procedures

Aircraft AFTO 781 series forms and IMDS revealed all required maintenance actions were in compliance with standard operating procedures (Tab D-5). During the MC's ground procedures, the MEW reported a noise emanating from the MA's air conditioning system. Maintenance personnel responded, investigated, and determined the noise to be inconsequential. The rest of the ground checks proceeded normally (Tabs R-181, V-11.4).

d. Maintenance Personnel and Supervision

The maintenance personnel involved in performing the maintenance on the MA were qualified (Tab U-22). Supervision reviewed the MA's forms and found no discrepancies preventing the MA from flight (Tab R-179).

e. Fuel, Hydraulic and Oil Inspection Analysis

The MA's oxygen was supplied by Andersen AFB's storage tanks. Samples taken from Andersen AFB's storage tanks were all within standards (Tab D-14). No samples could be obtained from the oxygen servicing cart because it had been purged for maintenance prior to the mishap (Tab D-14). Additionally, there were no discrepancies noted in any of the fuel, hydraulic, or oil Aerospace Ground Equipment used during servicing and launch of the MA (Tab D-14).

f. Unscheduled Maintenance

Since deployed to Andersen AFB, the MA landed in Code 3 status on three of its six sorties. Code 3 status is when an aircraft or system has a major discrepancy in mission essential equipment that may require repair or replacement prior to the next mission. All Code 3 discrepancies were repaired prior to the mishap sortie (Tabs U-14 - U-15, U-18 - U-19). A review of AFTO Form 95, Significant Historical Data, revealed no adverse trends. This form is used to permanently record major repairs and inspections to aircraft (Tab U-23).

6. AIRCRAFT AND AIRFRAME

During SAR and salvage operations, only a few parts of the MA were recovered (Tab J-18). All recovered items were submitted for testing (Tabs Q-15 - Q19, CC-12).

The MA's jackscrew was recovered during salvage operations. The jackscrew is a component of the stabilizer trim system (Tab CC-18). Analysis of the jackscrew revealed the MA stabilizer trim was set at 4.5-5.0 degrees nose down at impact. There was damage to the jackscrew that occurred during impact (Tabs J-216 - J-219, J-222). Additionally, the stabilizer trim actuator (motor) and other items normally attached to the jackscrew assembly were not recovered. The absence of these items makes it impossible to determine why the stabilizer trim was set to 4.5-5.0 degrees nose down at impact or whether it was functioning properly.

Parts of the elevator were recovered (Tab CC-12). The elevator is a control surface located on the tail of the aircraft which controls pitch (Tab DD-3, Figure 4). Analysis determined they were attached to the MA at the time of impact (Tabs J-216, J-221 - J-223). It cannot be determined whether the elevator was functioning properly at the time of the mishap.

Two of the flap track jack screws and their associated brackets were recovered (Tab CC-12). Analysis of these items determined the flaps were up at time of impact (Tabs J-216, J-221 - J-223).

Multiple sections of broken landing gear were located at the mishap site, however, they were not able to be recovered. Therefore, no determination could be made as to the position of the landing gear at time of impact (Tab CC-18).

7. WEATHER

a. Forecast Weather

Forecast weather for the mission was few clouds at 2,000 feet and scattered at 10,000 feet, with thunderstorms in the vicinity of Guam, with unlimited visibility (Tab F-3 - F-7).

b. Observed Weather

The weather observed by Andersen AFB weather operations at the time of the incident was few clouds at 1,900 feet and scattered clouds at 22,000 feet (Tab F-8 - F-10). COLT 11 reported one rain shower in the vicinity of the turn-in point for the flyby corridor; however, this only caused them to make a slight adjustment in their turn (Tab R-6). This cumulonimbus cloud was 20 NM away from the debris field (Tab R-6 - R-7). According to COLT 11, it was otherwise a clear day (Tabs R-5, V-4.13).

c. Space Environment

Not applicable.

d. Conclusion

Operations were conducted within the prescribed operational weather limitations.

8. CREW QUALIFICATIONS

a. Mishap Pilot (MP)

MP was a current and qualified Instructor Pilot in the B-52. He had 1,884.7 hours (Tab G-4 - G-11).

Mishap Pilot	Hours	Sorties
Last 30 Days	51.8	6
Last 60 Days	58.9	7
Last 90 Days	76.6	10

MP was known as a conservative pilot (Tabs R-122, R-130, R-149). He was also recognized for his perfect landing pattern procedures and control by the 20 EBS Commander (Tab V-8.11). Additionally, during the MP's upgrade to Instructor Pilot, he was graded outstanding during the Academic Phase and was graded excellent twice. His instructors remarked about his excellent performance, and stated he would make an invaluable asset to his Bomb Wing (Tab T-3 - T-4). As he was preparing for instructor training, he taught a low level employment simulator modeled to be in the vicinity of Guam and was recognized for the quality of his instruction (Tab T-5).

b. Mishap Copilot (MCP)

MCP was a current and qualified Copilot in the B-52. He had 385.3 hours as a Copilot in the B-52, and 1,391.0 hours as a Navigator in the C-130 (Tab G-12 - G-19).

Mishap Copilot	Hours	Sorties
Last 30 Days	44.0	4
Last 60 Days	59.9	7
Last 90 Days	83.0	12

MCP was also known as a conservative pilot and a solid leader with higher than normal situational awareness (Tabs R-76, R-121, V-8.12). During his formal training in the B-52, he excelled in all phases (Tab T-6). He had a reputation for being a good pilot and was well liked by his squadron (Tab V-8.12).

c. Mishap Radar Navigator (MRN)

MRN was a current and qualified Instructor Radar Navigator in the B-52. He had 1,046.9 hours in the B-52 and 355.8 hours as an instructor in the T-43 (Tab G-20 - G-27).

Mishap Radar Navigator	Hours	Sorties
Last 30 Days	14.4	2
Last 60 Days	14.4	2
Last 90 Days	29.7	4

MRN was known to be an outstanding and extremely sharp officer, instructor, and one of the most experienced Instructor Radar Navigators in the 20 EBS (Tabs R-93, R-121, R-125). He had a calm demeanor and handled high stress situations easily. His knowledge and flying abilities were among the best ever seen in the B-52 community. His depth of knowledge was instrumental in changing the format of training for all United States Air Force navigators. Based on his exceptional capabilities, he was chosen for, and completed, the highly selective Air Force Intern Program (Tab V-8.13).

d. Mishap Navigator (MN)

MN was a current and qualified Navigator in the B-52. He had 436.3 hours in the B-52 (Tab G-28 - G-33).

Mishap Navigator	Hours	Sorties
Last 30 Days	44.0	4
Last 60 Days	67.8	9
Last 90 Days	89.8	15

MN was viewed by his squadron commander to be one of the best navigators in the 20 EBS and had recently been ranked as the best navigator in his flight (Tab R-122). Noted as an outstanding young crewmember, his knowledge of the navigational systems exceeded his flight experience. He was very proactive and had an ability to prioritize and multi task while performing ground scheduling duties. He was known to be extremely hardworking, intelligent, and was an outstanding officer (Tab V-8.13).

e. Mishap Electronic Warfare Officer (MEW)

MEW was a current and qualified Electronic Warfare Officer in the B-52. He had 219.0 hours in the B-52 (Tab G-34 - G-41).

Mishap Electronic Warfare Officer	Hours	Sorties
Last 30 Days	44.0	4
Last 60 Days	52.8	5
Last 90 Days	95.6	11

Although MEW was new to the B-52, he had earned praise for his hard work and enthusiasm. According to his squadron commander, he was instrumental in the smooth operations of the squadron. He was a team player and could always be counted on for his quality work. He was considered by his squadron commander to be an "awesome" aviator and handled high stress environments well (Tab V-8.13 - V-8.14).

f. Mishap Flight Surgeon (MFS)

MFS was a fully qualified Senior Flight Surgeon (Tab G-42). He had flown in multiple aircraft throughout his career (Tab G-42 - G-51). This was his first sortie in the B-52. Flying time in his primary assigned aircraft was:

Mishap Flight Surgeon KC 135	Hours	Sorties
Last 30 Days	0	0
Last 60 Days	1.6	1
Last 90 Days	7.5	3

MFS was known as an outstanding officer, noted for his knowledge gained from a top notch medical school and prestigious residency program (Tab V-10.5, V-14.2, CC-14). Additionally, he was selected through a highly competitive process to serve at the NASA Kennedy Space Center (Tab CC-14). MFS was always willing to step up for extra work and held several different jobs within the Medical Group. He was instrumental in maintaining smooth working relations with all the local medical operations, especially with the Naval Base. He was also noted for enjoying his flying assignments and was excited about flying in the B-52 (Tabs V-8.14, V-14.2).

There is no evidence that crew qualifications were a factor.

9. MEDICAL

a. Qualifications

Medical records of the MC were reviewed and no discrepancies were identified. All MC were medically qualified to fly (Tab X-3).

b. Health

No discrepancies were identified. The MP was granted a medical waiver for a minor medical condition; this waiver was current until 31 August 2010 (Tab X-3). Additionally, three members of the MC were on medications that did not require waivers. These medications are on the Official Air Force Approved Aircrew Medications list (Tabs X-3, BB-3 - BB-23). There is no evidence to suggest the health of the MC was a factor.

c. Pathology

The remains of the MP, MRN, MN, and MFS were positively identified. The remains of the MCP and MEW have not been recovered. The MP, MRN, MN, and MFS's deaths were instantaneous due to blunt force trauma. Based on available evidence, the remaining MC's deaths were also presumed instantaneous. All toxicology studies performed after the mishap were negative for any unauthorized substances or alcohol use (Tab X-3).

d. Lifestyle

Based on a review of the MC's 72 hour and 14 day histories, medical records, and squadron leadership interviews, there is no evidence to suggest that unusual habits, behavior, or stress on the part of the MC were a factor (Tabs V-8.11, V-9.9, X-3).

e. Crew Rest and Crew Duty Time

Air Force Instruction 11-202, Volume 3, states Air Force aircrews require at least 10 hours of continuous restful activities including an opportunity for at least 8 hours of uninterrupted sleep during the 12 hours immediately prior to the flight duty period. All MC were given adequate opportunity for crew rest (Tabs V-9.10, X-3). There is no evidence to suggest crew rest was a factor.

10. OPERATIONS AND SUPERVISION

a. Operations

At the time of the accident, the 20 EBS had been deployed to Guam for 36 days, arriving on 16 June 2008, as part of a normally scheduled continuous bomber presence mission to the Pacific Area of Responsibility (AOR) (Tab CC-11). With the exception of the MFS, who was permanently stationed at Andersen AFB, the MC arrived in Guam approximately five weeks prior to the accident (Tab CC-11). The operations tempo of the squadron was fairly robust as compared to home operations with regard to flying but less so due to fewer additional duties and the reduction of normal family time and off-duty stresses (Tabs V-8.7, V-9.6). Most aircrew were getting one to two sorties a week, and many of the sorties were of longer duration due to exercises in the Pacific AOR (Tabs V-8.7, V-9.6 - V-9.7). The MC had last flown together on 14 July 2008, six days prior to the accident, with the exception of the MRN who last flew on 16 July 2008 and the MFS who had not previously flown on the B-52 (Tab CC-11).

The 14 July 2008 mission was an 18.5 hour Higher Headquarters Directed sortie to Hawaii and back as part of a Rim of the Pacific exercise (Tab CC-11). Witnesses testified the MC was fairly experienced and had functioned well as a crew (Tabs V-8.10 - V-8.14, V-9.9).

There is no evidence to suggest squadron operations tempo was a factor.

The mission was properly authorized and approved by the 20 EBS Director of Operations (Tab K-4). In addition, the flyby request was properly staffed and approved by Pacific Air Forces, Director of Operations, Plans, Requirements and Programs (Tab K-7 - K-8). A records review indicated all MC were current and qualified to participate in the scheduled sortie (Tab G-4 - G-51). The mission was planned for the MC by the 20 EBS MPC that included the 21 July 2008 Guam Liberation Day flyby. The mission also included a local tactical training portion to be conducted after the flyby. A PTOB was conducted by the MPC team chief that covered an overview of the mission, weather, intelligence, target study, all applicable items, events and procedures (Tabs R-158, R-161, V-1.2 - V-1.5). The flyby POC then conducted the flyby briefing. A crew brief was conducted afterwards by the MC, although no evidence exists to determine the sequence, items covered, or format of the flight briefing (Tab R-158). An Operational Risk Management (ORM) assessment was filled out by the MC and signed by the Director of Operations (Tab AA-6). Although the ORM paperwork had some minor errors, the risk level of the sortie was assessed as low.

There is no evidence to suggest squadron preparation and briefing was a factor.

b. Supervision

The leadership of the 36th Operations Group (36 OG) provided adequate supervision. Consistent with the expeditionary nature and structure of the 36 OG, the 21 July 2008 flyby was planned by a deployed aircrew member from the 20 EBS. This individual assisted in planning the 2007 flyby, also flown by the 20 EBS during their prior year's deployment to Guam (Tab V-1.3). The plan from 2007 was duplicated and accepted as a good plan by the 20 EBS Commander and the 36 OG Commander (Tabs V-6.3, V-8.2 - V-8.3). The squadron, group, and wing leadership was briefed the flyby plan (Tabs V-1.4, V-6.5, V-6.10). The 20 EBS Director of Operations attended a portion of the PTOB (Tab V-9.2). A Supervisor of Flying was present in his place of duty (Tab O-3 - O-6). However, it does appear that some of the flyby contingency plans were not completely understood by the entire chain-of-command. For instance, the flyby POC decided to change the previously approved TOT from 1000L to 1015L without informing the group leadership. (The TOT was subsequently changed back to 1000L by the flyby POC at approximately 0935L) (Tabs R-153, V-1.5, V-1.9, V-4.4, V-5.4, V-6.6). In addition, the group leadership was not aware the 20 EBS had scheduled an airborne backup for the flyby (RAIDER 22) (Tabs V-1.6, V-5.2 - V-5.3, V-6.6, V-9.5). Although not specifically required, a mass face-to-face flyby brief was not conducted with all participating aircrew (Tabs V-8.3, V-9.4, V-10.3). In fact, the MC and COLT 11 flight had not spoken to one another until established in the holding orbit (Tab V-4.3 - V-4.4).

There is no evidence to suggest supervision was a factor.

11. HUMAN FACTORS

a. Introduction

The Department of Defense Human Factors Analysis and Classification System includes a list of the potential human factors that may be contributory to a mishap (Tab BB-26 - BB-60). All factors in the guide were assessed for relevancy to the mishap.

A contributing factor is an event or condition that, if corrected, would not by itself have prevented an action or event. However, combined with other events or conditions, it influences the outcome of the action or event, either in occurrence or significance. A causal factor is an event or condition that either caused the occurrence under investigation or contributed to the unwanted result. If it were not for this event or condition, the unwanted result would not have occurred or would have been less severe (Tab CC-19).

The facts and circumstances surrounding this mishap made it difficult to definitively determine the mishap sequence. There were no witnesses, no survivors, no emergency radio calls, no cockpit recordings, and limited salvage. The available evidence suggests the MC was conscious and controlling the MA at the time of the mishap. Analysis of the Air Force Institute of Pathology and Brooks Life Sciences Equipment Laboratory reports are consistent with lack of successful ejection by the MC. The evidence indicates the possibility the MC may have been surprised by their situation and made late decisions regarding recovery of the MA. The MC made late ejection decisions (Tabs H-22 - H-66, X-3, CC-16 - CC-17).

b. Applicable Factors

The human factors that may have contributed to the mishap are:

Misperception of Operational Conditions is a factor when an individual misperceives or misjudges altitude, separation, speed, closure rate, sea conditions, aircraft location within the performance envelope or other operational conditions and this leads to an unsafe situation (Tab BB-50). According to T.O. 1B-52H-1, delaying ejection below 15,000 feet in a dive drastically decreases the chance of a successful ejection; this is reduced even more in a high speed dive. The late ejection attempt outside the performance envelope of the MA supports the probability that the MC misjudged their rate of acceleration, altitude, or ability to recover the MA (Tabs H-22 - H-66, X-3, CC-16 - CC-17).

Risk Assessment - During Operation is a factor when the individual fails to adequately evaluate the risks associated with a particular course of action, and this faulty evaluation can lead to inappropriate decisions and a subsequent unsafe situation. This failure occurs in real-time when formal risk-assessment procedures are not possible (Tab BB-40). The amount of time available in a low altitude environment to recognize an unusual occurrence, confirm flight parameters, and recover the aircraft or eject is reduced. According to T.O. 1B-52H-1, delaying ejection below 15,000 feet in a dive drastically decreases the chance of a successful ejection; this is reduced even more in a high speed dive. The MC may have failed to adequately assess the

capability to recover the aircraft in a low altitude environment (Tabs H-22 - H-66, X-3, CC-16 - CC-17).

Channelized Attention is when an individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others of equal or higher or more immediate priority. It is a tight focus of attention that leads to the exclusion of comprehensive situational information (Tab BB-44). It is possible the MC focused their attention on the mishap circumstances to the exclusion of their flight parameters. This is supported by the evidence of a late ejection attempt by the MC (Tabs H-22 - H-66, X-3, CC-16 - CC-17).

Temporal Distortion is a factor when the individual experiences a compression or expansion of time relative to reality leading to an unsafe situation (Tab BB-51). Based on the MA's descent profile, there was approximately 34 seconds from the presumed start of the mishap sequence until impact (Tab DD-5 - DD-6). The MC may have experienced compression of time during the mishap which could have led to late recovery and ejection decisions (Tabs H-22 - H-66, X-3, CC-16 - CC-17).

Although these factors may have been present, there is no evidence to suggest human factors were causal in this mishap.

12. FLIGHT SIMULATION

Flight simulators

Flight simulators are systems that recreate the operation of an aircraft as realistically as possible and are used to train flight crews in both normal and emergency situations. The 2 BW B-52 simulator and Boeing PC desk top simulator were used to recreate the MA's flight profile as realistically as possible. Multiple scenarios were run in these simulators to most closely match the MA flight profile in order to identify which conditions or malfunctions could explain the mishap or could be ruled out (Tab DD-3 - DD-47, J-78 - J-108, J-118 - J-189).

The 2 BW simulator has certified accurate modeling for airspeeds up to 390 knots indicated and the Boeing simulator has accurate modeling information for airspeeds up to 400 knots equivalent. Therefore, there may be discrepancies between the actual incident and the simulations run beyond the certified limits of the simulator (Tab DD-4). Additionally, there were noted differences in the data from the two simulators, specifically, the stabilizer trim setting at which the aircraft was unrecoverable. There were also variations in simulation results between multiple runs with similar parameters. Due to the dynamic environment of the simulator, no two runs could be precisely duplicated; however, after multiple simulator runs trends became apparent (Tab DD-4). Therefore, only general concepts can be drawn from the simulations.

Highly qualified and current B-52 Instructor Pilots were selected to perform the simulations. To begin the simulations, the aircrew started at 14,000 feet over open water, 240 knots of airspeed, with gear and flaps up. The simulator aircrew attempted to recreate the flight profile of the MC (Tab DD-4).

MA flight profile

Since there were no survivors or cockpit voice recorders to perfectly recreate the MA's flight parameters, the AIB utilized animation provided by the Mishap Analysis and Animation Facility, Air Force Safety Center, in order to recreate the accident in a flight simulator (Tabs S-28, DD-4). The animation was based off of ATC radar returns (Tab J-120). It should be noted the ATC radar is not a precise instrument and therefore extrapolations were made to "best fit" the flight path (Tabs J-88, J-91). Figure 3 displays data extrapolated from the animation.

Time	Elapsed Time mm:ss	Heading	Calibrated Air Speed	Bank	Pitch Degrees	Altitude	Vertical Velocity Indicator
0953:11	00:00	256	240	0	0	14124	244
0953:17	00:06	252	239	12	3 NU	14146	94
0953:25	00:14	244	239	21	2 ND	14109	-1032
0953:30	00:19	236	243	37	7 ND	13892	-3686
0953:36	00:25	231	257	29	11ND	13420	-7429
0953:42	00:31	224	296	40	23ND	12312	-13866
0953:46	00:35	218	321	50	30ND	11280	-18037
0953:51	00:40	207	340	34	30ND	9613	-20117
0953:56	00:45	200	358	10	23ND	8051	-18057
0954:00	00:49	199	388	0	23ND	6793	-17151
0954:06	00:55	199	435	0	23ND	5144	-20051
0954:08	00:57	199	468	0	29ND	4098	-24654
0954:11	01:00	199	495	0	33ND	2905	-27571
0954:16	01:05	199	510	0	33ND	2344	-28464

NU= Nose Up; ND= Nose Down

Figure 3 - MA Flight Parameters

Through extensive interviews, exhaustive simulator and computer modeling, the expertise and experience of the AIB members, and utilizing Boeing engineering analysis, numerous scenarios were able to be ruled out (Tabs J-41 - J-189, DD-3 - DD-6).

1. Engine flameout: Engine flameouts were simulated throughout the descent, including total engine flameout and multiple variations of engine flameouts. During each of the simulations, any combination of engine failure was recoverable during the flight profile (Tab DD-6).

2. Airspeed indicator inoperative: There are multiple redundancies within the aircraft's airspeed indicator system. These redundancies are built into the system to ensure airspeed indications are available. Additionally, the airspeed indicator system does not affect the capability of the pilots to control the aircraft (Tab J-80 - J-81).

3. Aircraft explosion: No explosions were reported by any aircraft in the vicinity of the flight path. There is no scorching, burn marks, or other indications on the remains or on the recovered wreckage consistent with a fire or explosion (Tabs H-22 - H-66, X-3).

4. Mid-air collision: Mid-air collision was ruled unlikely due to the lack of ATC and COLT 11 radar returns of other aircraft in the approach corridor (Tab N-6 - N-7). Additionally, there is no evidence of wreckage from other aircraft in the debris field and no reports of aircraft missing in the local area.

5. Hydraulic failure: Due to the multiple redundancies inherent in the hydraulic system, failure is considered remote. It would require a simultaneous failure of four independent hydraulic systems and a failure of the crew to turn on a standby hydraulic pump (Tab J-37 - J-38).

6. Electrical failure: The transponder is controlled by DC power and operates on 115 volts AC power. The transponder requires both power sources to respond to interrogations. The last interrogation by the transponder was recorded at approximately 2,000 feet. The transponder responds to interrogations to report altitude and position to ATC radar. Evidence of the transponder operating during the mishap sequence indicates the MA had full electrical power prior to impact (Tab J-75).

7. Separation of wing structure or tail structure: The MA was within its design limitations until shortly before impact (Tab J-42 - J-47). The pieces recovered were consistent with damage caused by impact. There was no evidence to suggest structural failure (Tabs J-27, J-216, J-223). If the wing or tail structure had separated from the MA during flight, the pitch and bank changes demonstrated by ATC radar would not have occurred (Figure 3). This is indicative of the presence of the control surfaces (elevator and spoiler) on the wing and tail sections necessary to affect pitch and bank control during the mishap sequence. This suggests there was no separation of wing or tail structure during flight (DD-6).

8. Life raft deployment impeding the yoke: There are three known instances of unplanned inflation of the pilot's or copilot's seat kit life raft in a B-52 (Tabs J-71, DD-6). Boeing has stated life raft inflation may push the yoke full forward (Tab J-81). In these three instances, the aircraft was able to be recovered and landed safely (Tab DD-6). Modeling information provided by Boeing demonstrates pitch changes occurred through flight, which is consistent with active control of the yoke (Tab J-41). There is very limited data or capability to simulate a situation when life raft inflation could push the yoke to an intermittent position, thus giving the crew limited yoke authority.

After ruling out the above scenarios as improbable, the AIB was led to focus on problems with stabilizer trim setting.

Elevator and stabilizer trim

The elevator and stabilizer trim are control surfaces that are located on the tail of the aircraft (Figure 4). They are used together in order to maintain pitch of the aircraft. Normally, the pilot uses his elevator to control pitch initially and then will use stabilizer trim to relieve control forces. The elevator is controlled by the yoke; the control surface moves through a system of pulleys, cables and hydraulic actuators (motors). The stabilizer trim is controlled primarily through the use of a switch on the yoke; it is controlled through electrical switches that control the stabilizer trim actuator (motor) (Tab DD-3). The stabilizer trim control system provides pitch trim by movement of the entire horizontal stabilizer surface (Tab J-67). There is a manual control wheel that can be used in an emergency situation when the electrical trim function is not available. The elevator and stabilizer trim control surfaces are normally used in sequence during all phases of flying, and techniques for proper utilization are taught throughout a pilot's career (DD-3).

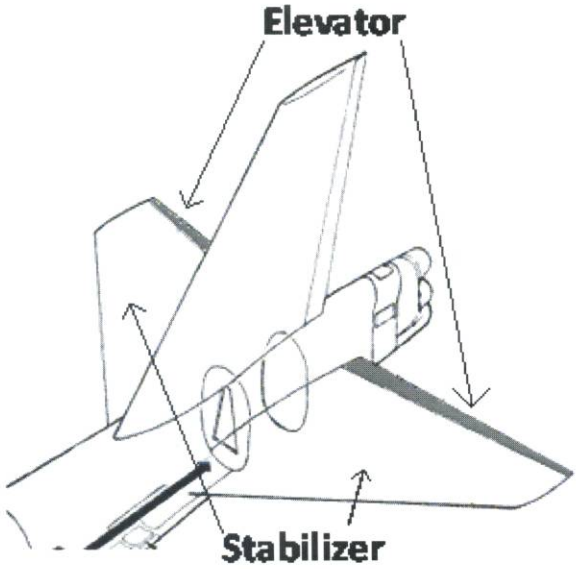

Figure 4: Elevator and Stabilizer Trim

There are flight parameters where the elevator control authority is not enough to counteract the position of the stabilizer trim. According to Boeing, "[a]ircraft control must be maintained even though the runaway may cause an extreme stabilizer deflection that will exceed the authority of the elevator, especially in the high speed flight regime" (Tab DD-57). In other words, if the stabilizer trim is positioned in an abnormal nose low position either intentionally, inadvertently or through a failure of the system, pulling full yoke back may not be enough to return the aircraft to level flight. Analysis showed the MA's stabilizer trim was set at 4.5-5.0 degrees nose down at impact (Tab J-222). This is an unusual stabilizer trim setting and does not correspond to proper recovery techniques (Tab DD-5). In order to recover, a pilot's trained reaction is to raise the nose through the combination of elevator and nose up stabilizer trim. If the stabilizer trim was fully functional and the crew was applying proper recovery techniques, the aircraft would have recovered as shown in both the 2 BW and Boeing simulators (Tabs DD-5, DD-39). Boeing data establishes at 6,793 feet (the point of rollout), if the stabilizer trim was actuated electrically at a

normal rate from a start point of 7.0 degrees nose down, the MC should have recovered within 3,000 feet (Tab DD-39).

In the 2 BW simulator, there were multiple interrelated control forces that could be manipulated to recreate the MA's flight profile. The interrelation of the position of the stabilizer trim and the airspeed of the aircraft proved important during the simulations. Since the exact position of the stabilizer throughout the mishap sequence is unknown, simulations were performed with a wide range of stabilizer trim settings (Tab DD-4). The following trend information was discovered:

1. As the aircraft accelerates, the larger size of the stabilizer as compared to the relatively smaller elevator surface results in the stabilizer overpowering the elevator (Figure 4). Therefore, the ability of the elevator to counter a stabilizer mistrim is reduced at higher speeds (Tabs DD-4, DD-38).

2. Reaction time before attempting to reset the stabilizer towards neutral or nose up was critical. The more nose down the initial setting of the stabilizer, the more crucial immediate action became (Tab DD-4).

Possible scenarios

Scenario 1

In the 2 BW simulator, with the pitch set to 23 degrees nose down with a stabilizer trim of 5.0 degrees nose down, when the airspeed exceeded 420 knots the elevator did not have enough authority to counteract the pitch down force of the stabilizer, restricting the ability to return to level flight. If the MC were able to reset the stabilizer trim, even if they delayed applying nose up stabilizer trim until an extremely low altitude, the aircraft should have been recoverable. Additionally, if the stabilizer was never set past 5.0 degrees nose down and the pilots attempted to recover prior to 420 knots indicated airspeed, they should have been able to recover. For the MA to have been unrecoverable, the MC would have had to: 1) inadvertently or mistakenly trim past a normal setting of 3.0-4.0 degrees to 5.0 degrees nose down; and 2) delay recovery past the operational limit of the indicated airspeed of 390 knots until 420 knots; and 3) use improper recovery techniques by not using stabilizer trim in conjunction with the elevator (Tab DD-4 - DD-5).

Scenario 2

Runaway stabilizer trim is an event where the stabilizer moves uncommanded by the pilots, which could cause an unwanted pitch change to the aircraft. There are single point failures that could cause the stabilizer trim to runaway: a failure of either pilot's trim switch on their respective yoke, stabilizer trim relay (located in the back section of the aircraft), a mechanical failure that could affect the hydraulic actuator, or autopilot inputs to the stabilizer system (Tab DD-5). Although there are redundancies in the stabilizer trim system, there is at least one reported B-52D model mishap where a "malfunction in the stabilizer electrical control system" is listed as the most probable cause (Tab J-88). There is also one documented case of a B-52G experiencing uncommanded stabilizer trim movement during ground operations (Tab DD-52). During a runaway stabilizer trim, the pilots' emergency actions are to disengage and turn off the autopilot (which could be responsible for the runaway stabilizer trim), and then cutout electrical power to the stabilizer through a guarded switch. After the cutout switch is used, the stabilizer

can only be readjusted by the pilots through the use of the manual control wheel (Tab DD-5). The manual control wheel can be adjusted at an approximate rate of 1 degree every 2.5 seconds (Tab DD-3).

The following flight profile was accomplished in the simulator (Figure 5). Approximately 31 seconds after beginning the turn and descent, the stabilizer trim began to run away from approximately 4.0 degrees nose down to 6.5 degrees nose down. This time equates to the approximate time that MA began to pitch nose down and bank beyond the previously established 30 degree bank angle. In the simulator, 7 seconds later, the stabilizer trim was stopped at approximately 6.5 degrees nose down by use of cutout force switch. The simulator crew utilized approximately 29 seconds to recognize the stabilizer trim malfunction, perform the emergency actions, analyze the fact that the aircraft is not recovering, and communicate among the pilots how to recover, and then they began to manually adjust the stabilizer trim from 6.5 to 5.0 degrees nose down. The simulator crew then took 3 seconds to determine that the aircraft was unrecoverable and began to simulate ejection (Tab DD-5 - DD-6). Analysis has shown that the MP ejected approximately 2 seconds prior to impact (Tab CC-16 - CC-17). Once the MP initiated ejection, it can be reasonably assumed that the aircraft was no longer trimmed. Using a 30,000 feet per minute rate of descent, it was estimated that the MA impacted the water 1 minute and 5 seconds after beginning the initial turn and descent (Tab DD-6). Analysis of the jackscrew confirmed the stabilizer was set to approximately 4.5-5.0 degrees nose down at impact (Tab J-222). According to Boeing, "[i]t must be acknowledged that effective aircraft control could be lost under various combinations of aircraft configuration, airspeed, altitude, and weather, even if the pilots execute response actions perfectly" (Tab DD-57).

Time	Elapsed Time mm:ss	Heading	Calibrated Air Speed	Bank	Pitch	Altitude	Vertical Velocity Indicator	Simulator Crew Actions
0953:11	00:00	256	240	0	0	14124	244	
0953:17	00:06	252	239	12	3 NU	14146	94	
0953:25	00:14	244	239	21	2 ND	14109	-1032	
0953:30	00:19	236	243	37	7 ND	13892	-3686	
0953:36	00:25	231	257	29	11ND	13420	-7429	
0953:42	00:31	224	296	40	23ND	12312	-13866	Runaway Stab Trim Started
0953:46	00:35	218	321	50	30ND	11280	-18037	
0953:51	00:40	207	340	34	30ND	9613	-20117	-Recognize
0953:56	00:45	200	358	10	23ND	8051	-18057	-Confirm
0954:00	00:49	199	388	0	23ND	6793	-17151	-Bold Face
0954:06	00:55	199	435	0	23ND	5144	-20051	-Reassess
0954:08	00:57	199	468	0	29ND	4098	-24654	-Start Manual Trim
0954:11	01:00	199	495	0	33ND	2905	-27571	Ejection Decision
0954:14	01:03							Ejection
0954:16	01:05	199	510	0	33ND	2344	-28464	Impact

NU= Nose Up; ND= Nose Down

Figure 5 - Simulator Profile Data

13. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications

1. Air Force Instruction (AFI) 11-202, Volume 1, *Aircrew Training*, 17 May 2007
2. AFI 11-202, Volume 2, *Aircrew Standardization/Evaluation Program*, 8 December 2006, Incorporating Change 1, 19 September 2007
3. AFI 11-202, Volume 3, *General Flight Rules*, 5 April 2006
4. AFI 11-209, *Aerial Event Policy and Procedures*, Pacific Air Forces Command Supplement, 4 May 2007
5. AFI 11-2B-52, Volume 3, *B-52 - Operations Procedures*, 2d Bomb Wing Supplement, 19 November 2006

b. Maintenance Directives and Publications

1. AFI 21-101, *Aerospace Equipment Maintenance Management*, 29 June 2006, Combat Supplemental, 24 April 2007
2. Technical Order (T.O.) 00-20-1, *Aerospace Equipment Maintenance, General Policies and Procedures*, 14 December 2007
3. T.O. 1B-52H-1, *Flight Manual*, dated 1 April 2007, Change 2 - 1 March 2008
4. T.O. 1B-52H-2-2GA-1, *Ground Handling, Servicing, and Airplane Maintenance*, 28 June 2002, Change 12, 30 July 2008
5. T.O. 1B-52H-2-36GA-1, *Egress Systems and Jettisonable Equipment*, 6 January 2003, Change 6, 30 January 2008

c. Known or Suspected Deviations from Directives or Publications

There are no known or suspected deviations from directives or publications by crew members or others involved in the mishap mission.

14. NEWS MEDIA INVOLVEMENT

Local, national, and international media outlets immediately reported on this mishap. Barksdale AFB created web pages dedicated to the MC. The 2d BW Commander gave two press conferences. Local Shreveport press covered the salvage operations (Tab CC-13).

24 November 2008

MARK A. BARRETT
Brigadier General, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

B-52H, T/N 60-053
30 NM NORTHWEST OF GUAM
21 JULY 2008

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report may not be considered as evidence in any civil or criminal proceeding arising from the accident, nor may such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.

1. Background: On July 21, 2008, at 0859 local time (L), a B-52H aircraft, call sign RAIDER 21, tail number 60-053 (MA), deployed to the 20th Expeditionary Bomb Squadron, 36th Wing departed Andersen AFB, Guam, to accomplish a local training mission that included performing a flyby in support of the Guam Liberation Day celebration. The flyby was to occur at 1000L in the vicinity of downtown Agana, Guam, near the World War II Park and the Governor's Complex, at 1,000 feet. A 2-ship flight of F-15Es, COLT 11 flight, was also scheduled to perform in the flyby, one minute after the MA.

The mishap crew (MC) attended a pre-takeoff briefing scheduled to start at 0500L. The MC was briefed by the squadron mission planning cell who prepared the mission materials. The MC then continued their standard crew mission briefing. There was no mass flyby briefing for the participating aircrews.

MA ground operations were unremarkable, and the MA was airborne at 0859L. The MA proceeded to and entered the pre-planned holding orbit at 14,000 feet, 30 nautical miles (NM) northwest of Guam. At 0927L, COLT 11 flight departed Andersen AFB, proceeded to the flyby holding orbit and established holding 1,000 feet above and approximately 4 to 6 miles behind the MA. At 0952L, the mishap crew (MC) informed the Air Traffic Control (ATC) authority they were about to leave the holding orbit and confirmed the approach corridor from the holding orbit to Guam was clear. COLT 11 flight turned away from the MA to gain the desired one minute spacing and last saw the MA in a left turn toward the coast of Guam. The MA continued its left hand turn toward the flyby inbound leg and began a descent. At 0955L, ATC radar returns no longer tracked the MA, and it is assumed the MA impacted the surface of the ocean at approximately 0955L, 30 NM northwest of Guam. The aircraft was destroyed. All six aircrew members on board the aircraft are presumed to have died instantly upon impact.

2. Cause: The Accident Investigation Board (AIB) president found by clear and convincing evidence that the cause of this mishap was the mis-positioning of the stabilizer trim (stab trim).

Through extensive interviews, exhaustive simulator and computer modeling, and the expertise, experience and opinion of the AIB members, the AIB ruled out multiple causes and numerous scenarios due to lack of supporting evidence. The radar data and model-driven animation that approximated the turn, descent and ultimate crash of the MA allowed the AIB to model around that profile. Based upon this profile and the recovered stab trim jackscrew, the AIB focused on

the stabilizer trim setting and possible problems with the stabilizer trim function to explain a dangerous situation that would have been difficult to recognize or recover.

The evidence indicates that the stab trim was set at ~5.0 degrees nose low at impact. This indicates an improper stab trim setting of an aircraft in a nose low descent at low altitude. However, with no eyewitness accounts, surviving aircrew members, emergency radio calls or "black box" recordings, and minimum recovered aircraft control surfaces/instruments, the specific reason the stab trim is in an improper position cannot be determined.

The AIB recreated two possible scenarios that could reasonably explain the positioning of the stab trim at impact, the situation the mishap crew encountered, and account for their inability to recover the mishap aircraft. Either of these situations would have required a very timely recognition of the event and swift execution of proper procedures to recover the aircraft. Based on the nose low aircraft attitude and the relatively low altitude, either of these rapidly developing scenarios could have surprised even a very experienced crew.

a. Scenario 1:

The pilot-flying the aircraft (PF) initiated a left bank turn as the MA departed the west end of the holding orbit. Almost simultaneously, the PF pushed the nose down to begin a descent from 14,000 feet to 1,000 feet. Multiple simulator runs and analysis by Boeing modeling show that as the MA turns and descends, the PF would begin to trim the stabilizer down to assist in the handling of the aircraft. It is possible that if the PF over-trimmed or inadvertently trimmed to a ~5.0 degree nose low setting, which would be excessive for this descent. As the altitude decreased and the airspeed increased, recognition of the developing, potentially dangerous situation and then application of proper recovery controls would have to occur fairly quickly before the elevator authority would be ineffective. If the MC delayed recovery past the operational limit of the indicated airspeed of 390 knots, and used improper recovery techniques by not using stabilizer trim in conjunction with the elevator, then the MA would be unrecoverable. The AIB estimated that this recognition, assessment, and recovery would have to occur within approximately 40 seconds after the descent was initiated. The numerous simulator tests indicate that the MA would have been recoverable any time before these parameters are met. This scenario implies that the entire MC was distracted from the current aircraft parameters. Although plausible, the training, qualification, and experience level of the aircrew, the characteristics of a multi crew aircraft, and the relatively benign nature of the initial descent, makes this scenario unlikely.

b. Scenario 2:

The PF initiated a left bank turn as the MA departed the west end of the holding orbit and almost simultaneously pushed the nose down to begin a descent from 14,000 feet to 1,000 feet. Multiple simulator runs and analysis by Boeing modeling show that as the mishap aircraft turns and descends, the PF would begin to trim the stabilizer down to assist in the handling of the aircraft. If at that moment or soon after, the aircraft experienced a runaway trim malfunction (greater than 5.0 degrees nose down), the PF would have to recognize the malfunction, assess the

situation, and then apply proper procedures to recover from the situation. The AIB estimated that this sequence would have to occur within approximately 20 seconds after the runaway trim malfunction. If a runaway trim malfunction did occur, the stab trim could only be adjusted manually. This manual adjustment takes 2 to 3 seconds per degree of nose trim, which could account for the stab trim being set at ~5.0 degrees nose down upon impact (one pilot attempting to manually trim the stab from an extreme nose down position). Based on the nose low attitude and the relatively low altitude, even an experienced aircrew who found themselves in this situation could have found it difficult to recognize the emergency and then recover the aircraft. If recognition of the emergency does not occur almost immediately, the aircraft is unrecoverable. The AIB president determined that this scenario was most likely.

3. Contributing Factors: The AIB also thoroughly researched all possible and potential factors that could have substantially contributed to this mishap. There is no evidence to suggest the following were factors in the mishap: weather; crew experience and qualification level; operations tempo; supervision; maintenance forms documentation, inspections, procedures, personnel and supervision; medical, life style and crew rest issues; squadron preparation and briefing; and life support equipment, egress, and survival. With regard to the MC's mission planning, the AIB president believes the mishap crew may not have properly planned the entire execution of the flyby portion of the mission to the extent necessary to ensure safe execution of all required maneuvers to arrive at the flyby location. However, there is insufficient evidence to suggest the MC's mission planning was a substantially contributing factor.

The AIB president believes there are two factors which contributed substantially to the mishap: 1) the combination of low altitude with a descending left turn of the MA; and 2) late recognition of the serious nature of the situation by the MC.

The relatively low altitude, high descent rate, and steep descent angle, minimized the MC's available reaction time if a dangerous situation developed. This situation left little margin of error for the MC, and was a substantially contributing factor.

However, a dangerous situation did develop and a delay of as little as 20 seconds to recognize, confirm, and apply appropriate recovery procedures, placed the MA in an unrecoverable situation. In addition, late ejection attempts by several of the MC is further evidence of a late recognition of the dangerous situation, and late recognition was a substantially contributing factor in this mishap.

4. Summary:

The Accident Investigation Board President found by clear and convincing evidence that the cause of this mishap was a mis-positioning of the stabilizer trim. With no eyewitness account, surviving aircrew members, emergency radio calls or "black box" recordings and with minimal recovered aircraft control systems/instruments, the specific reason the stab trim was in an improper position cannot be determined. The Accident Board President found two factors which contributed substantially to the mishap: 1) the combination of low altitude with a descending left turn of the MA; and 2) late recognition of the serious nature of the situation by the MC. Even an

experienced aircrew could have found it difficult to recognize, assess, and recover from the very rapidly developing situation involving the stab trim setting.

24 November 2008

MARK A. BARRETT
Brigadier General, USAF
President, Accident Investigation Board